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January 27, 1998

To: Distribution List

From: Principal Environmental Specialist S. W. Krasner

Subject: Bromodichloromethane Formation in Metropolitan's Waters

1. Bromodichloromethane (BDCM) ($CHCl_2Br$) is one of the four regulated trihalomethanes (THMs). Recent data suggest that this THM may be of higher health concern than the other three THM species. Future disinfection by-product (DBP) regulations may include regulations for individual DBPs of health concern in addition to regulations for the class sums (such as total THMs).

2. Figure 1 shows the effect of raw-water total organic carbon (TOC) and bromide (Br^-) on BDCM formation. For a specific value of bromide, increases in TOC result in increases in BDCM formation. For a specific value of TOC, increases in bromide result in increases in BDCM formation except for at very high bromide concentrations (in the range of 0.4 to 0.8 mg/L) at which the THM speciation is shifted to the formation of dibromochloromethane and bromoform.

3. Figure 2 shows the monthly variability in BDCM in Metropolitan's filtration plant effluents from 1990 to 1997. Prior to implementation of the Surface Water Treatment Rule (SWTR) in 1992, the Mills plant used chloramines only except for on selected dates in which free chlorine was used for taste-and-odor control. Although chloramines only greatly reduced THM formation, their use as the primary disinfectant was precluded by the SWTR. The Mills plant has experienced significant shifts in BDCM formation (Table 1) due to wide variations in TOC and bromide concentrations in State Project water (SPW). Because of the long detention time in the Pyramid-Castaic lake system, the "peaks" and "valleys" in TOC and bromide concentrations are "blended out," resulting in less variability in BDCM formation at the Jensen plant (Table 1).

Table 1. Monthly Variability in BDCM in Metropolitan's Filtration Plant Effluents, 1990-1997

Statistic	Mills	Jensen	Weymouth	Skinner	Diemer
Minimum	2.2	13	6.8	7.2	5.9
10th Percentile	3.0	15	9.2	8.8	8.4
25th Percentile	10	17	12	12	11
Median	21	18	15	14	14
Mean	19	18	15	15	14
75th Percentile	26	21	18	18	19
90th Percentile	32	23	22	22	21
Maximum	53	28	24	25	23

4. Although total THM formation is significantly lower at the three plants that treat primarily Colorado River water (CRW) (i.e., Weymouth, Skinner, Diemer), there is sufficient bromide in CRW (typically 0.08 mg/L) in order to form significant amounts of BDCM (Table 1). Thus, Metropolitan's distribution system--which includes blends of treated SPW and CRW--have relatively high amounts of BDCM. Nationwide, the median and 90th percentile concentrations of BDCM are 10 and 23 µg/L, respectively. Metropolitan's waters have relatively high concentrations of BDCM because our source waters are relatively high in bromide. Nationwide, the median and 90th percentile concentrations of raw-water bromide in surface waters are 0.05 and 0.16 mg/L, respectively.

5. One means of controlling THM formation is the use of ozone/chloramines. However, a short free-chlorine contact time is still required to inactivate heterotrophic-plate count bacteria in the filter effluent of an ozone facility. In limited tests, BDCM formation in ozonated SPW--which has undergone a short free-chlorine contact time prior to chloramination--has ranged from <1 to 7.3 µg/L.

6. Another means of controlling THM formation is the use of enhanced coagulation. However, prechlorination would still need to be practiced in order to meet the SWTR disinfection requirements. In limited tests, BDCM formation in chlorinated SPW--which has undergone enhanced coagulation--has been 6.4 and 8.6 µg/L.

Distribution List:
M. D. Beuhler
R. L. Wolfe
M. K. Davis
J.-M. Bruno
B. Koch
M. Torobin

Figure 1

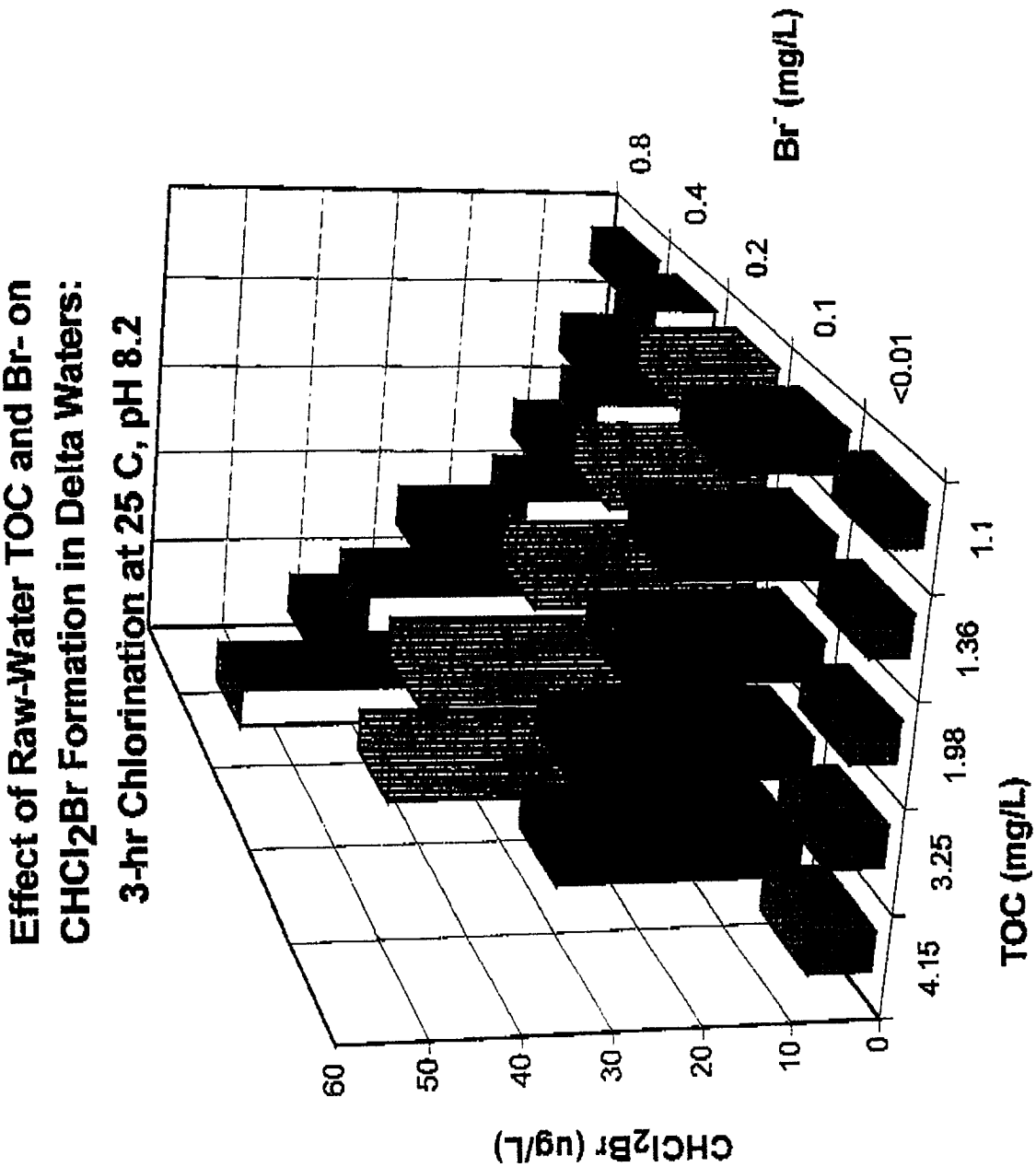
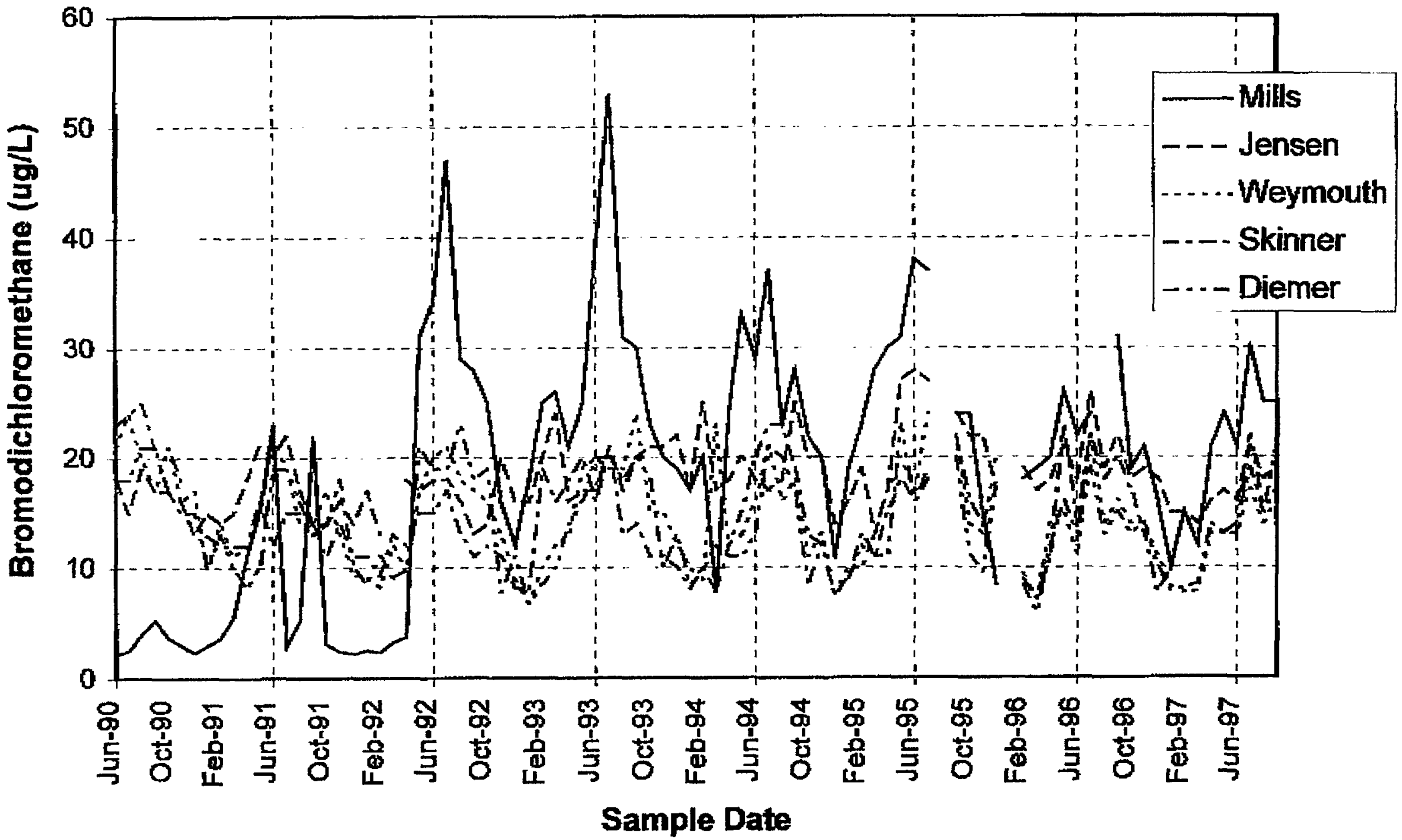

Effect of Raw-Water TOC and Br- on
CHCl2Br Formation in Delta Waters:
3-hr Chlorination at 25 C, pH 8.2
Br- (mg/L)
0.8
0.4
0.2
0.1
<0.01
TOC (mg/L)
4.15
3.25
1.98
1.36
1.1
CHCl2Br (ug/L)
0
10
20
30
40
50
60

Figure 2

Monthly Variability in Bromodichloromethane in Metropolitan's Filtration Plant Effluents, 1990-1997



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INCREMENTAL ADDITIONAL CAPITAL AND OPERATIONS AND MAINTENANCE COSTS FOR TREATMENT TECHNOLOGIES TO MEET STAGE II D/DBP REGULATIONS IN STATE PROJECT WATER

COSTS BASED ON A DESIGN FLOW CAPACITY = 1,880 MGD

NO.	TREATMENT TECHNOLOGY OR COMBINATION OF TECHNOLOGIES	COST PER ACRE-FOOT (AF)		TOTAL COST
		INCREMENTAL ADDITIONAL CAPITAL COST PER AF[1]	INCREMENTAL ADDITIONAL O&M COST PER AF[2]	INCREMENTAL ADDITIONAL CAPITAL COST[3]
1	Ozone/PEROXONE[4]	$18.30/AF	$9.46/AF	$449,500,000
2	pH Control[5] [pH control to limit bromate formation]	$0.43/AF	$13.59/AF	$10,500,000
3	Ozone/PEROXONE[4] + pH Control[5]	$18.73/AF	$23.05/AF	$460,000,000
4	Enhanced Coagulation[6]	$5.78/AF	$27.98/AF	$142,000,000
5	Enhanced Coagulation[6] + Ozone/PEROXONE[4] + pH Control[5]	$24.51/AF	$51.03/AF	$602,000,000
6	Reverse Osmosis Membranes[7]	$74/AF	$263/AF	$1,821,000,000

Note:

[1]Capital costs per acre-foot calculated using design flow in acre-feet per year through Metropolitan Water District of Southern California (Metropolitan) water treatment plants

[2]Operations and maintenance costs per acre-foot calculated using average flow through Metropolitan's water treatment plants

[3]Total capital costs calculated for facilities necessary to treat a design flow of 1,880 mgd

[4]Capital costs for ozone/PEROXONE facilities based on information from Metropolitan's Engineering Division (costs include ozone facilities, hydrogen peroxide facilities, and engineering design). O&M costs to generate and feed ozone and to feed hydrogen peroxide based on information from J. D. Kostelecky of Metropolitan's Water Quality Division. Ozonation at ambient pH (no pH adjustment).

[5]Capital and O&M costs for pH control to limit bromate production based on information from B. M. Coffey of Metropolitan's Water Quality Division (include acid and caustic feed facilities). pH control to limit bromate to 5 ug/L to meet Stage II D/DBP Anticipated Regulations.

[6]Capital and O&M costs for enhanced coagulation based on information from J. F. Green of Metropolitan's Water Quality Division for the Jensen and Mills filtration plants.

[7]Capital and O&M costs for reverse osmosis membrane facilities based on a study and memorandum by R. S. Yates and R. C. Cheng of Metropolitan's Water Quality Division.